# Alveolar ridge preservation in the esthetic zone

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Abstract: In the esthetic zone, in the case of tooth extraction, the clinician is often confronted with a challenge regarding the optimal decision-making process for providing a solution using dental implants. This is because, after tooth extraction, alveolar bone loss and structural and compositional changes of the covering soft tissues, as well as morphological alterations, can be expected. Ideally, the therapeutic plan starts before tooth extraction and it offers three options: spontaneous healing of the extraction socket; immediate implant placement; and techniques for preserving the alveolar ridge at the site of tooth removal. The decision-making process mainly depends on: (i) the chosen time-point for implant placement and the ability to place a dental implant; (ii) the quality and quantity of soft tissue in the region of the extraction socket; (iii) the remaining height of the buccal bone plate; and (iv) the expected rates of implant survival and success. Based on scientific evidence, three time-periods for alveolar ridge preservation are described in the literature: (i) soft-tissue preservation with 6-8 weeks of healing after tooth extraction (for optimization of the soft tissues); (ii) hard- and soft-tissue preservation with 4-6 months of healing after tooth extraction (for optimization of the hard and soft tissues); and (iii) hard-tissue preservation with > 6 months of healing after tooth extraction (for optimization of the hard tissues).

DOI: https://doi.org/10.1111/prd.12209

# Alveolar ridge preservation in the esthetic zone

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Running title: Alveolar ridge preservation in the esthetic zone

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## Abstract

In the esthetic zone, in case of tooth extraction, the clinician is often confronted with a challenging situation regarding the decision-making for an optimal treatment solution using dental implants. This is due to the fact that following tooth extraction, alveolar bone loss, structural and compositional changes of the covering soft tissues as well as morphological alterations can be expected. Ideally, the therapeutic plan starts before tooth extraction and offers three therapeutic options: spontaneous healing of the extraction socket, immediate implant placement and techniques for preserving the alveolar ridge at the site of tooth removal. The decision-making process mainly depends on i) the time-point chosen and the ability to place a dental implant, ii) the soft tissue quality and quantity in the region of the extraction socket, iii) the remaining height of the buccal bone plate and, iv) the expected implant survival and success rates. Based on scientific evidence, three healing time-points for alveolar ridge preservation are described in the literature including the need for an optimization of the soft tissues (soft tissue preservation with 6-8 weeks healing after tooth extraction), of the hard and soft tissues (hard- and soft tissue preservation with 4-6 months healing after tooth extraction) and of hard tissues (hard tissue preservation with >6 months healing after tooth extraction).

## Anatomy of the extraction socket in the esthetic zone

Following tooth extraction, alveolar bone loss, structural and compositional changes of the covering soft tissues as well as morphological alterations can be expected (30). The numerous alterations in the alveolar process may lead to difficulties at the time of implant placement when a prosthetically driven implant position is desired (11).

In order to understand the changes following tooth extraction in the esthetic zone, it is fundamental to comprehend the anatomical and histological characteristics of tissues surrounding the tooth foreseen for extraction. Being part of the periodontium, the alveolar process surrounds the fully erupted tooth. Histologically, the inner part of the socket wall contains lamellar bone, the so-called bundle bone (2). The thickness of this bundle bone is reported to be 0.2 to 0.4 mm (29). Similar to the root cementum and the periodontal ligament, its existence is strictly tooth-dependent (2).

In order to measure the thickness of the buccal bone plate in the maxillary anterior area, cone beam computed tomographies were obtained in a recent clinical study. The thickness of the buccal bone plate was measured at three different positions relative to the buccal bone crest (18). It was found that the buccal bone plate in most locations in the anterior maxilla was less than 1mm in thickness. In addition, nearly 50% of the investigated sites had a bone plate, which was at maximum 0.5 mm thick. This is turn means that the bundle bone and the buccal bone plate commonly have a similar thickness in the anterior maxillary region. Therefore, one might assume that after tooth extraction in the esthetic area the buccal bone plate will be resorbed predominantly in the more crestal region.

In the esthetic zone, therefore, the clinician is confronted with a challenging situation regarding the decision-making for an optimal treatment solution. Hence, in recent years, the healing process of the extraction socket and the related changes of respective hard and soft tissues following tooth removal has become a well-investigated research field. Ideally, the therapeutic plan starts before tooth extraction and offers three therapeutic options: spontaneous healing of the extraction socket, immediate implant placement and techniques for preserving the alveolar ridge at the site of tooth removal. The focus of this narrative

review is on alveolar ridge preservation techniques in the esthetic zone. Beside the evidential background of alveolar ridge preservation procedures, this article provides a clinical decision tree and corresponding cases demonstrating the different treatment options.

## Spontaneous healing following tooth extraction

After tooth extraction, the alveolar ridge undergoes evident reduction in both vertical and horizontal directions (7, 8, 19). The processes taking place after tooth removal were systematically reviewed in an article, which included 20 human studies and aimed to assess the magnitude of dimensional changes of both the hard and soft tissues of the alveolar ridge after tooth extraction (35). Based on the evidence of the review, the vertical dimensional reduction on the buccal side amounted to 11 – 22 % (-1.24 ± 0.11mm) after 6 months, whereas a horizontal dimensional reduction on the buccal side was even more pronounced and amounted to 29-63% (-3.79 ± 0.23 mm) after 6 to 7 months (35). It was concluded that human re-entry studies demonstrated rapid alteration within the first 3 – 6 months after tooth removal followed by gradual reduction in dimension thereafter. Subsequently, 0.5 – 1 % reduction of the bone contour per year can be expected (6). In summary, following single-tooth extraction, up to 50% of the ridge width will be resorbed and bone resorption will predominantly occur at the buccal aspect (2).

## Immediate implant placement

Immediate implant placement can be performed in a variety of therapeutic procedures: either with or without flap elevation and with and without additional guided bone regeneration procedures.

The hard-tissue alterations following immediate implant placement without guided bone regeneration procedures were evaluated in a study including 18 patients with a total of 21 teeth scheduled for extraction (10). Following flap elevation and tooth removal, an implant was placed without additional membranes or bone substitute materials (10). The follow-up

examination at 4 months of healing demonstrated a horizontal resorption of the buccal bone dimension of roughly 56% at the buccal aspect and 30% at the lingual and palatal aspect (10). This is underlined by further preclinical and clinical studies demonstrating that immediate implant placement in fresh extraction socket fails to prevent bone resorption (3-5, 15, 26, 28).

The outcomes of immediate implants were also assessed concomitant with guided bone regeneration procedures (12). The aim of that prospective clinical study was to evaluate the clinical performance of immediately placed implants. In total, 30 patients received immediate transmucosal implants in the maxillary anterior region. The implants were randomly assigned into three treatment groups: whereas 10 patients received implants without additional guided bone regeneration procedures, 10 patients received implants grafted with demineralized bovine bone matrix alone and, in 10 patients grafted with demineralized bovine bone matrix and a collagen membrane. The horizontal resorption at 4 years amounted to 48.3% in the group without grafting material, whereas in the other two groups significantly less horizontal resorption was observed: 15.8% in the group with demineralized bovine bone matrix and 20% in the group with demineralized bovine bone matrix and a collagen membrane (12).

In summary, immediate implant placement without additional guided bone regeneration procedures results in a reduction of the ridge dimension of about half of the initial bone width in a horizontal dimension and therefore seems not to be beneficial when compared to spontaneous healing (2, 10). However, less horizontal bone resorption can be expected by adding a grafting material and combining immediate implant placement with a guided bone regeneration procedure.

## Alveolar ridge preservation procedures

Alveolar ridge preservation techniques have been widely used in the past and are continuously evaluated. These techniques are performed to counteract soft and hard tissue changes that follow tooth extraction. More recent research has focused on a variety of

materials and techniques with different aims depending on the need for soft and/or hard tissue preservation as well as on the optimization of the ridge profile. According to previews systematic reviews (14, 16, 24, 40), three options for alveolar ridge preservation exist encompassing the use of soft tissue grafts, hard tissue graft materials or a combination of soft and hard tissue biomaterials. Main goals include the elimination or at least a limitation of post extraction ridge alterations, the promotion of soft and hard tissue healing within the former extraction socket, and facilitating the placement of dental implants in a prosthetically ideal position without the need for further augmentative procedures (16, 24). From a clinical point of view, the decision for a certain alveolar ridge preservation technique mainly depends on i) the time-point chosen and the ability to place a dental implant, ii) the soft tissue quality and quantity in the region of the extraction socket, iii) the remaining height of the buccal bone plate and, iv) the expected implant survival and success rates. Ideally from a patient's perspective, dental implants are placed immediately. However, this technique is associated with a number of limitations and in addition, might not be suitable in all cases. This is mostly due in cases of existing deficiencies in terms of bone and soft tissues. Therefore, if an alveolar ridge preservation is performed, three healing time-points are described in the literature, focusing on the need for an optimization of the soft tissues (soft tissue preservation with 6-8 weeks healing after tooth extraction), of the hard and soft tissues (hard- and soft tissue preservation with 4-6 months healing after tooth extraction) and of hard tissues (hard tissue preservation with >6 months healing after tooth extraction) (13).

***Soft tissue preservation***

In case, the soft tissues demonstrate a deficiency prior to or after tooth extraction, alveolar ridge preservation procedures have been described to enhance the missing soft tissue quality and/or regenerate the quantity. From a material point of view, available options include the use of an autogenous subepithelial connective tissue graft, harvested from the

tuberositas area or the palate, a free gingival graft, harvested from the palate, a soft tissue substitute or a resorbable membrane that enhance the soft tissue wound closure (9, 21, 31-34). These procedures are predominantly performed with a flapless approach or with a minimal coronal flap advancement, in order to preserve or gain keratinized tissue. Scientific evidence ranges from a variety of preclinical studies to clinical studies applying different biomaterials also on the level of the hard tissue (17, 22, 36, 41). Since the healing period for such an intervention is kept to 6-8 weeks, only minimal new bone formation can be expected within the socket, but complete soft tissue closure (23). The biomaterials mainly serve as a space-maintaining device for the biomaterial or the graft placed at the soft tissue level. Due to heterogeneity of the studies using various biomaterials and techniques, outcomes are difficult to compare. To date, however, the use of an autogenous soft tissue graft appears to be the most suitable method to optimize the ridge profile on the soft tissue level considering short-term healing periods (37, 38). Alternative soft tissue substitutes, which appear to reduce postoperative morbidity (39), have not been documented as extensively for short healing periods and can currently not replace the use of autogenous tissue (38).

***Hard- and soft tissue preservation***

In some clinical cases, not only hard but also soft tissue deficits may be observed following tooth extraction. In these cases, more recent techniques suggested a combination of soft and hard tissue preservation with a longer-term healing period (4-6 months) applying a minimally invasive, non-flapped approach. These so-called socket seal techniques combine the use of biomaterials that are placed at the bony level and of autogenous soft tissue grafts or of soft tissue substitutes at the level of the soft tissues (20, 23, 25, 27). In one of the earlier studies, a xenogenic bone substitute material with 10% collagen was used and a soft tissue seal obtained with a free gingival punch graft harvested from the palate (21). This study demonstrated a successful integration of the soft tissue graft, volumetric changes and implant-related outcomes, however, were not assessed. More recent studies evaluated the same combination and compared different alveolar ridge preservation techniques also using

a soft tissue substitute (collagen matrix) (1, 20, 23). It was demonstrated that after a healing period of 6 months, alveolar ridge preservation with a xenograft and the extraction socket sealed with an autogenous soft tissue graft or a collagen matrix were effective (20, 23, 27) and even superior to control groups (spontaneous healing or a biomaterial without a seal) (20). Horizontal and vertical changes were minimal (20) and allowed placing dental implants with high survival rates at the one-year follow-up (27). Histologic outcome measures additionally revealed that the placement of a graft material within the socket retarded healing. This was suggested to be a major contributing factor that these sites underwent only minimal dimensional changes of the extraction socket sites (1, 23). Moreover, it was demonstrated that soft tissue substitutes could be successfully used as socket seal for alveolar ridge preservation, allowing for a simplification of the procedure. The use of autogenous grafts can possibly be avoided thereby reducing the postoperative morbidity of patients (20, 27).

***Hard tissue preservation***

In case of a severe loss of the buccal bone plate (>50%), hard tissue preservation with a prolonged healing time prior to implant placement has been suggested. For that purpose, alveolar ridge preservation is performed using a bone substitute material covered with a membrane followed by flap advancement to achieve complete or partial wound closure (most commonly used), a bone substitute material with full wound closure by coronal advancement or rotation of the flap (second most common technique), a bone substitute material without wound closure (weakest evidence) (for a an overview see (14, 40)). Various materials were used for these procedures, but none of the material or techniques demonstrated to be more favorable than others (24). Based on meta-analyses statistically significant less reduction of bone height (vertical dimension) for alveolar ridge preservation compared to control groups (weighted mean difference = 1.47mm) and statistically significant less reduction of bone width (horizontal dimension) for alveolar ridge preservation compared to controls (weighted mean difference = 1.83mm). In addition, a significant positive effect of a flapped surgery was observed (40). This clearly demonstrated a superiority of alveolar ridge preservation

compared to control groups when it comes to changes of the ridge profile following tooth extraction. Apart from benefits in terms of soft and hard tissue changes, other outcomes, such as the need for further bone augmentation, the feasibility of implant placement and implant survival and success rates, might further support the use of alveolar ridge preservation techniques. Based on a more recent systematic review, meta-analyses demonstrated a need for further bone augmentation at implant placement ranging between 0% and 15% for alveolar ridge preservation and between 0% and 100% for spontaneous healing (24). This indicated a decrease in the need for further bone augmentation with a relative risk of 0.15 (95% confidence interval 0.07-0.3) for alveolar ridge preservation compared to controls. Since in all included studies, implant placement was feasible, no advantage of alveolar ridge preservation compared to controls is evident. Whereas this may not be in favor of alveolar ridge preservation procedures per se, one needs to understand that implant placement can be conducted in most cases independent whether or not alveolar ridge preservation or spontaneous healing was performed. Given the fact that backwards planning and not bone-driven implant placement appears to be the state-of-the-art implant therapy, it is crucial to report where the implants were placed, which diameters were used and which angulation was chosen. This information can currently not be derived from the scientific evidence and therefore might underestimate the effect of alveolar ridge preservation in daily routine practice. Similar data with no differences in terms of implant survival and success rates and marginal bone level changes are reported for alveolar ridge preservation sites and control sites (24). Overall, the data derived from the literature support the use of alveolar ridge preservation to preserve the ridge volume, mainly on the hard tissue level, but do not offer more clinical benefits in terms of implant-related outcomes, are associated with a long healing period (>6 months) and a flapped procedure.

## Clinical concept for alveolar ridge preservation procedures

### Clinical decision-making process

When it comes to the esthetic area, the clinical concept in today's dentistry has clearly changed in a way that the treatment plan and the decision-making process should take place before a tooth is going to be extracted. This allows benefiting from the multiple treatment options that are available at the time of tooth extraction.

All treatment modalities have their individual aims, clinical indications and limitations (Table 1). The aim of this part of the review is to present a decision tree (Fig. 1) followed by a therapeutic concept illustrated by clinical cases (Figures 2-5). Figure 1 shows the decision tree, which starts with the most general question, which needs to be asked before a tooth is going to be extracted (Q1):

**"Is implant placement possible or indicated within the next 0 to 2 months after tooth extraction?"**

If the answer is yes (A1.1) and implant placement is possible and indicated within the next 0 to 2 months an alveolar ridge preservation procedure is generally not indicated. However, an additional question needs to be asked before tooth extraction: **"Do the soft tissues need to be optimized prior to implant placement?"** (Q2.1). If the answer is no (A2.1), the extraction socket is left for spontaneous healing with subsequent implant placement 6-8 weeks later (Type 2 implant placement according to (13) or an immediate implant placement (Type 1 implant placement according to (13)) is indicated. The decision on the timing for implant placement is based on patient-related, clinical and radiographic findings and is not part of the present review.

In cases with soft tissue deficiencies and defects at the time of tooth extraction, a soft-tissue preservation technique (*soft-tissue preservation*) is indicated in order to improve the soft tissues at this early time-point (A.2.2). This generally includes the need for bone graft materials and autogenous soft tissue grafts.

If the answer is no and implant placement is not possible or is indicated at a later time-point (> 2 months) an *alveolar ridge preservation* procedure might be recommended according to todays literature (A1.2). In order to find the right technique, the subsequent question is related to the amount of the remaining buccal bone (Q2.2): **"How much buccal bone is**

**available after tooth extraction?"**. If at least 50% of the buccal bone plate is intact, a flapless ridge preservation procedure (*hard- and soft-tissue preservation = socket seal technique*) using a slowly resorbing graft material and either an autogenous graft or a collagen matrix is indicated (A2.3). If more than 50% of the buccal bone plate is missing, good documentation is available for a standard open flap ridge preservation/augmentation technique (*hard-tissue preservation*) using current guided bone regeneration procedures (A2.4). Hence, the more invasive and technique sensitive procedure is indicated for larger bone defects, whereas the flapless procedures are indicated for extractions sockets with smaller bone defects.

***Clinical concept for soft-tissue preservation* with an autogenous soft tissue graft *(Figure 2)***

The clinical concept starts in general with a correct diagnosis and thorough analysis of the clinical and radiographic situation. Depending on the difficulty of the extraction, the tooth is going to be removed either with a flapless or an open flap access. When ever possible a flapless procedure should be selected. In a representative clinical case a 29 years old women presented with an ankylosed tooth 11 revealing a vertical soft and hard tissue deficiency. Due to an external buccal root resorption the tooth needs to be extracted and the patient is asking for an improved esthetic situation. For the compensation of the soft tissue defect an autogenous connective tissue graft from the palate was selected. A soft tissue substitute or an autogenous punch graft do not allow for the augmentation of such an extended defect. Following atraumatic tooth extraction, a partial flap elevation using a tunnel technique without any further incision was performed. The extension of the flap elevation includes the buccal, the palatal as well as the interproximal part and should allow for a tension-free insertion of the connective tissue graft. After elevation the socket is going to be filled with a deproteinized bovine bone mineral embedded in a 10% collagen matrix. Thereafter, the connective tissue graft is placed underneath the elevated gingiva and is stabilized by vertical mattress sutures on the buccal and the palatal part. The orifice of the socket is going to be reduced by cross sutures. Subsequently, the temporary removable

prosthesis is going to be adjusted to avoid excessive pressure on the augmented site. The patient receives antibiotics immediately before tooth extraction and for another 5 days postoperatively. Analgesics are going to be prescribed according to the patients need. The patient is asked not to mechanically clean this area and is rinsing with a chlorhexidine solution (0.2%) for 7-10 days until the day of suture removal.

After a healing period of at least 6-8 weeks the next therapeutic interventions can be started. In the present situation the patient received an implant with a simultaneous guided bone regeneration procedure 3.5 months later. Since the flapless ridge preservation can only maintain the buccal contour to about 80-85% (20) an additional contour augmentation is needed in highly esthetic cases. Therefore, in the present case a further contour augmentation using demineralized bovine bone matrix and a collagen membrane was performed. After a further healing period of 2 months abutment connection was performed and eventually, an all-ceramic implant-retained crown 11 was inserted. In order to close the diastema a ceramic veneer on 21 and an additional partial veneer on 12 were inserted. The 5-year follow-up represents a stable and harmonious esthetic outcome.

**Clinical concept for hard- and soft tissue preservation (socket seal technique) with hard- and soft tissue substitutes (Figure 3)**

A 31 years old pregnant women presented with a mesio-distally fractured tooth 24 revealing a high lip line. Due to the fact that she was pregnant, implant surgery could not be scheduled and was not expected to be performed for a longer time. Hence, it was decided to perform an alveolar ridge preservation procedure in order to maintain at least 80-85% of the buccal contour facilitating implant placement when the patient is coming back a few months later. Since there was no need for an improvement of the soft tissue thickness, it was decided to perform a socket seal technique using a slowly resorbing bone substitute material (demineralized bovine bone matrix plus collagen) covered by a collagen matrix. After gentle tooth extraction and cleaning of the socket using hand instruments and saline solution the demineralized bovine bone matrix with collagen was applied and the 8mm diameter collagen

matrix was sutured to the host gingival margin. 6 months later implant placement was possible without any further augmentation and the implant was left for transmucosal healing. Another 6 weeks later a screw-retained all-ceramic crown was inserted revealing a perfect soft tissue contour.

**Clinical concept for hard- and soft-tissue preservation (socket seal technique) with a hard tissue substitutes and an autogenous soft tissue graft (Figure 4)**

A 24 years old male medical student showed up with pain at his central right incisor 11. The clinical assessment demonstrated buccal fistulas, however, without increased pocket depth. The cone beam computed tomography revealed a large apical and pararadicular radiolucency involving also the apex of tooth 12 but with intact vitality. The buccal bone plate seemed to be partially intact at least in the coronal part. Due to the fact that the patient was currently taking his exams he was not ready for implant placement. Therefore, implant placement was not possible within the next 0-2 months and an alveolar ridge preservation procedure was indicated. The level of the soft tissue margin of tooth 11 before tooth extraction was more apically compared to the gingival margin of the contralateral tooth. In order to compensate for this slight soft tissue deficiency it was decided to harvest an autogenous graft from the palate to seal the extraction socket. After atraumatic tooth extraction it became obvious that tooth 11 had a long root fracture. After gentle cleaning the granulation tissue at the apex of 12 the extraction socket including the apical bone defect was filled with demineralized bovine bone matrix with collagen up to the level of the palatal bone. After harvesting the autogenous punch graft from the palate (21) the graft was meticulously sutured to the host soft tissue margin. The postoperative regime was the same as described in the section "*Soft-tissue preservation techniques".* Seven months later the soft contour was partially maintained and implant placement was indicated. The open flap approach revealed very nice bone regeneration of the entire area except for some fibrous tissue disto-coronally, which was removed before implant insertion. Keeping the large bone defect at the time of tooth extraction in mind the socket seal technique was considered to be

very effective in order to facilitate implant placement in a correct prosthetically-oriented position. Again, this described technique did not allow for a 100% maintenance of the buccal contour and therefore, a buccal contour augmentation with demineralized bovine bone matrix collagen and a collagen membrane was subsequently performed. The implant was left for submucosal healing and 3 months later abutment connection was performed. After soft tissue conditioning of the peri-implant mucosa a screw-retained all-ceramic crown was inserted. The final clinical picture presents an esthetically pleasing result with a harmonious soft tissue appearance.

**Clinical concept for hard-tissue preservation (Fig. 5) with a guided bone regeneration technique**

A 37 years old female patient shows up with a fistula buccal 11 and a probing depth of 10 mm at the buccal aspect of tooth 11. The diagnosis was a vertical root fracture of tooth 11 after trauma. Due to the expected large buccal bone defect an open flap access was chosen. After flap elevation it was obvious that implant placement was not possible due to a 14mm bone defect and the proximity to the nasal floor. Subsequently, the extraction socket and the buccal bone contour were augmented using a demineralized bovine bone matrix material mixed with autogenous bone from the surrounding tissue and covered with a collagen membrane. The membrane was additionally stabilized with resorbable pins made of poly-lactid. Based on systematic reviews it was shown that a significant better outcome could be achieved when the flap was closed (40). In this particular case a palatal pedicle flap was prepared in order to close the orifice of the extraction socket. Following a healing period of 6 months the implant could be inserted without any further intervention and could be left for transmucoal healing. Subsequently a screw-retained porcelain-fused to metal crown was inserted.

## Conclusion

The clinical decision-making process for alveolar ridge preservation in the esthetic zone starts before tooth extraction. Whenever a failing tooth can be replaced by an implant 0-2 months after tooth extraction no alveolar ridge preservation is indicated. The only exceptions are cases with soft tissue defects at the time of tooth extraction in which a soft tissue preservation technique can improve the soft tissues. In all other cases where implant placement is not possible or not indicated 0-2 months after tooth extraction, alveolar ridge preservation procedures should be taken into consideration.

## Acknowledgments

The work on this review was funded by the Clinic of Fixed and Removable Prosthodontics and Dental Material Science, University of Zurich, Switzerland.

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Figure 1. Clinical decision tree, leading to the different alveolar ridge preservation procedures.

Figure 2. Ankylosed tooth 11 revealing a vertical soft and hard tissue deficiency (A). Atraumatic tooth extraction (B). Partial flap elevation using a tunnel technique (C). Filling the extraction socket with a deproteinized bovine bone mineral

embedded in a 10% collagen matrix (D). Placement of a connective tissue graft (E) underneath the elevated gingiva (F). Postoperative situation after adjusting the temporary removable prosthesis to avoid excessive pressure on the augmented site (G). Suture removal after 7 days (H). Situation after a healing period of 3.5 months (I, J). Implant placement with a simultaneous guided bone regeneration procedure (K, L, M, N). Suture removal after 1 week of healing (O). 5-year follow-up of the all-ceramic implant-retained crown 11 and the veneer on 21, showing harmonious esthetic outcome (P).

Figure 3. Mesio-distally fractured tooth 24 (A, B). Situation after tooth extraction (C) and application of demineralized bovine bone matrix with collagen (D). 8mm diameter collagen matrix sutured to the host gingival margin (E). 6 months after healing (F). Implant placement without any further augmentation (G, H ) and transmucosal healing (I). Clinical situation another 6 weeks later with a screw-retained all-ceramic crown (J, K).

Figure 4. Central right incisor 11 with buccal fistulas and increases pocket depth (A). Cone beam CT revealing a large apical and pararadicular radiolucency involving also the apex of tooth 12 (B). Filling of the extraction socket including the apical bone defect with demineralized bovine bone matrix with collagen (C). Sutured punch graft to the host soft tissue margin of the extraction socket (D). Clinical situation seven months later, showing a partially maintained soft contour (E, F). Flap elevation revealing nice regenerated bone in the entire area except for some fibrous tissue disto-coronally (G, H). Implant placement in a correct prosthetically-oriented position (I, J). Buccal contour augmentation with demineralized bovine bone matrix collagen and a collagen membrane (K, L). Submucosal healing of the implant (M, N) for 3 months. Insertion of a implant supported provisional crown (Q, R), allowing for soft tissue conditioning of the peri-implant mucosa (S, T). Inserted screw-retained all-ceramic crown was inserted, showing an esthetically pleasing result with a harmonious soft tissue appearance (U, V)

Figure 5. Fistula buccal of the tooth 11 with a probing depth of 10 mm at the buccal aspect (A). X-ray showing an extensive root canal treatment (B). The diagnosis was a vertical root fracture of tooth 11 after trauma. Open flap access to extract the tooth (C, D). Buccal bone contour augmentation using a demineralized bovine bone matrix material mixed with autogenous bone from the surrounding tissue and covered with a collagen membrane (E, F, G). A palatal pedicle flap was prepared in order to close the orifice of the extraction socket (H, I). Following a healing period of 6 months (J), the implant could be inserted without any further intervention (K, L) and could left for transmucoal healing (M). Clinical situation with a screw-retained porcelain-fused to metal crown (N).

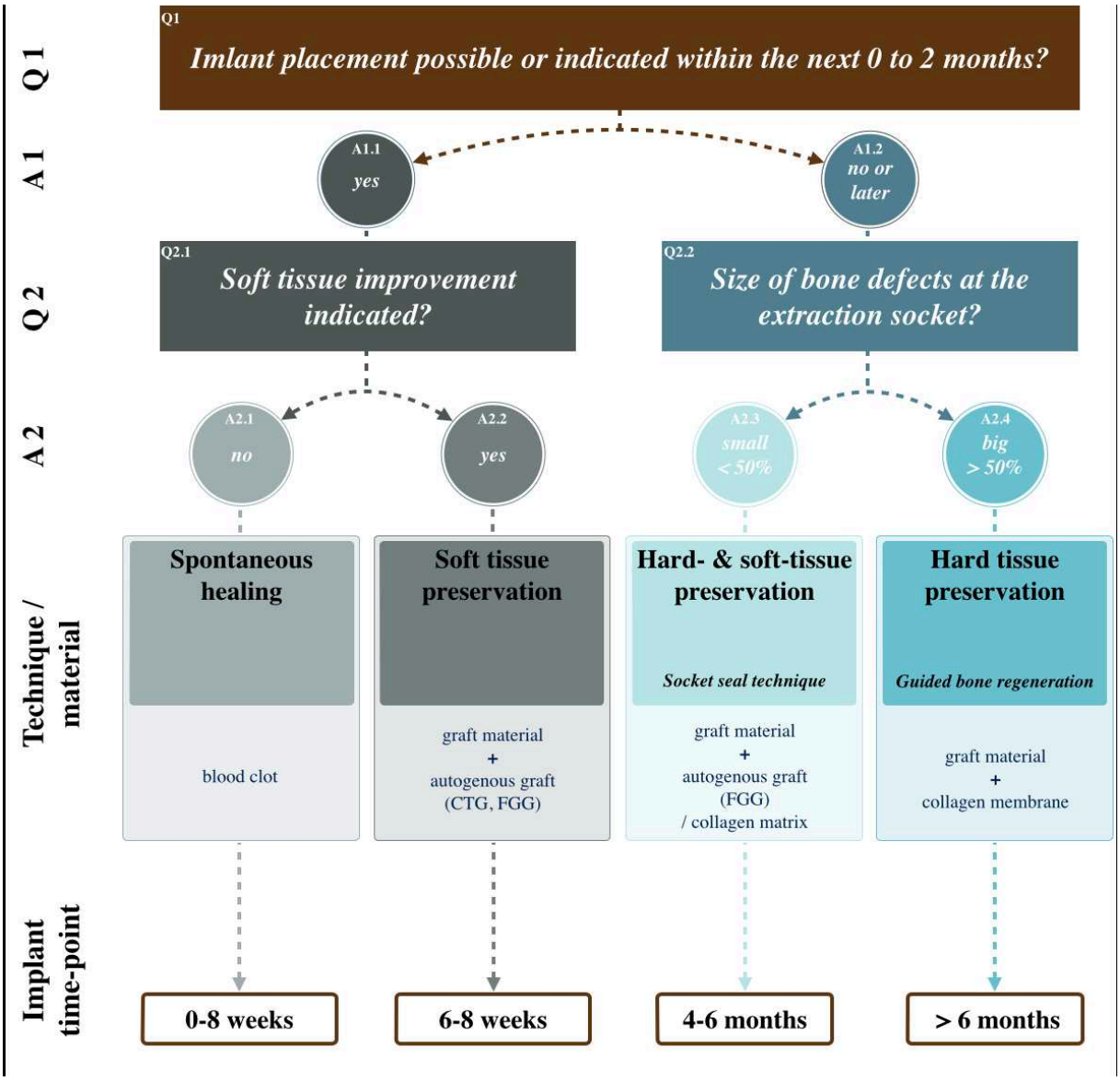
Q1
A1
Q2
A2
Technique / material
Implant time-point
Q1
Imlant placement possible or indicated within the next 0 to 2 months?
A1.1
yes
A1.2
no or later
Q2.1
Soft tissue improvement indicated?
Q2.2
Size of bone defects at the extraction socket?
A2.1
no
A2.2
yes
A2.3
small
< 50%
A2.4
big
> 50%
Spontaneous healing
blood clot
Soft tissue preservation
graft material
+
autogenous graft
(CTG, FGG)
Hard- & soft-tissue preservation
Socket seal technique
graft material
+
autogenous graft
(FGG)
/ collagen matrix
Hard tissue preservation
Guided bone regeneration
graft material
+
collagen membrane
0-8 weeks
6-8 weeks
4-6 months
> 6 months

Figure 1

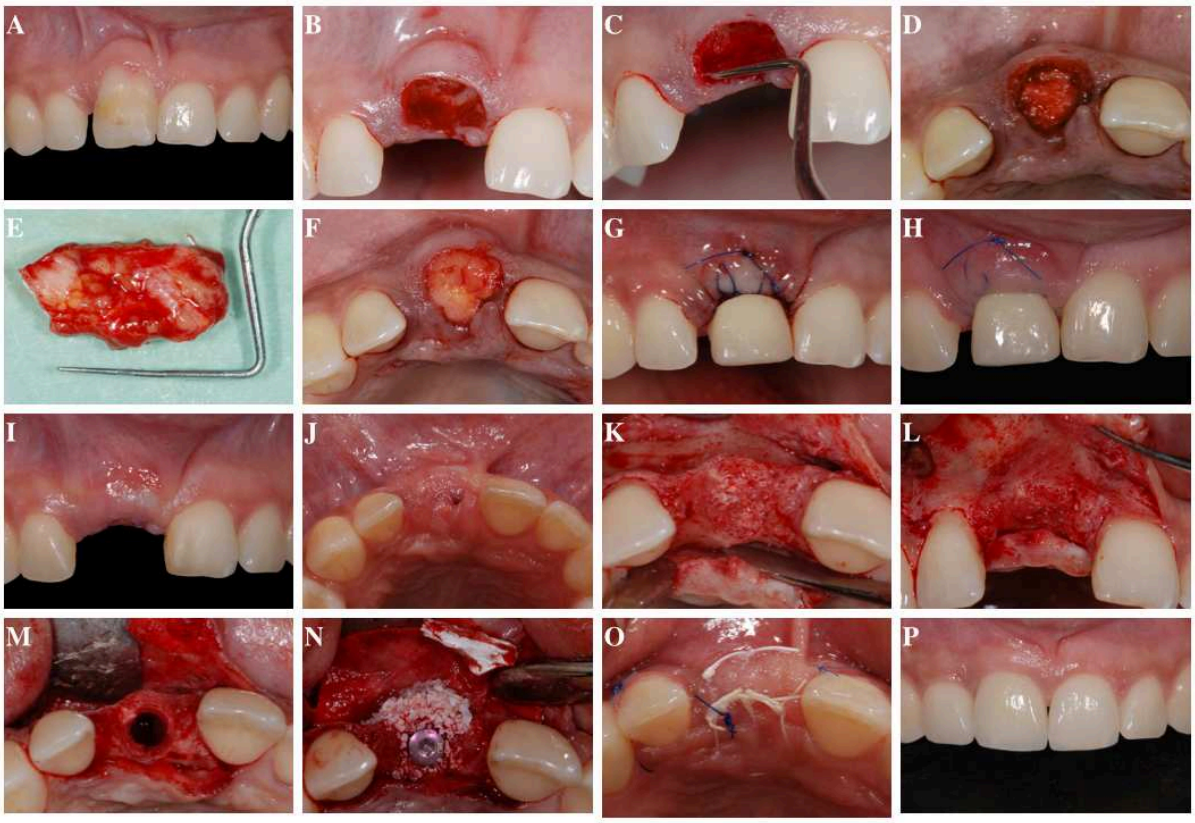


Figure 2

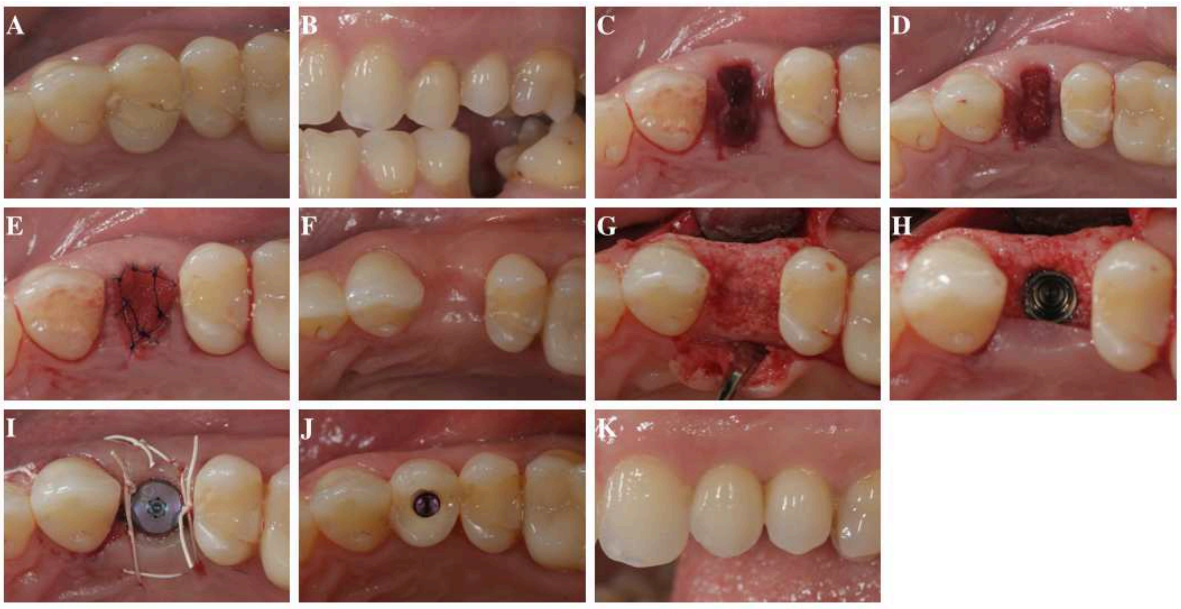


Figure 3

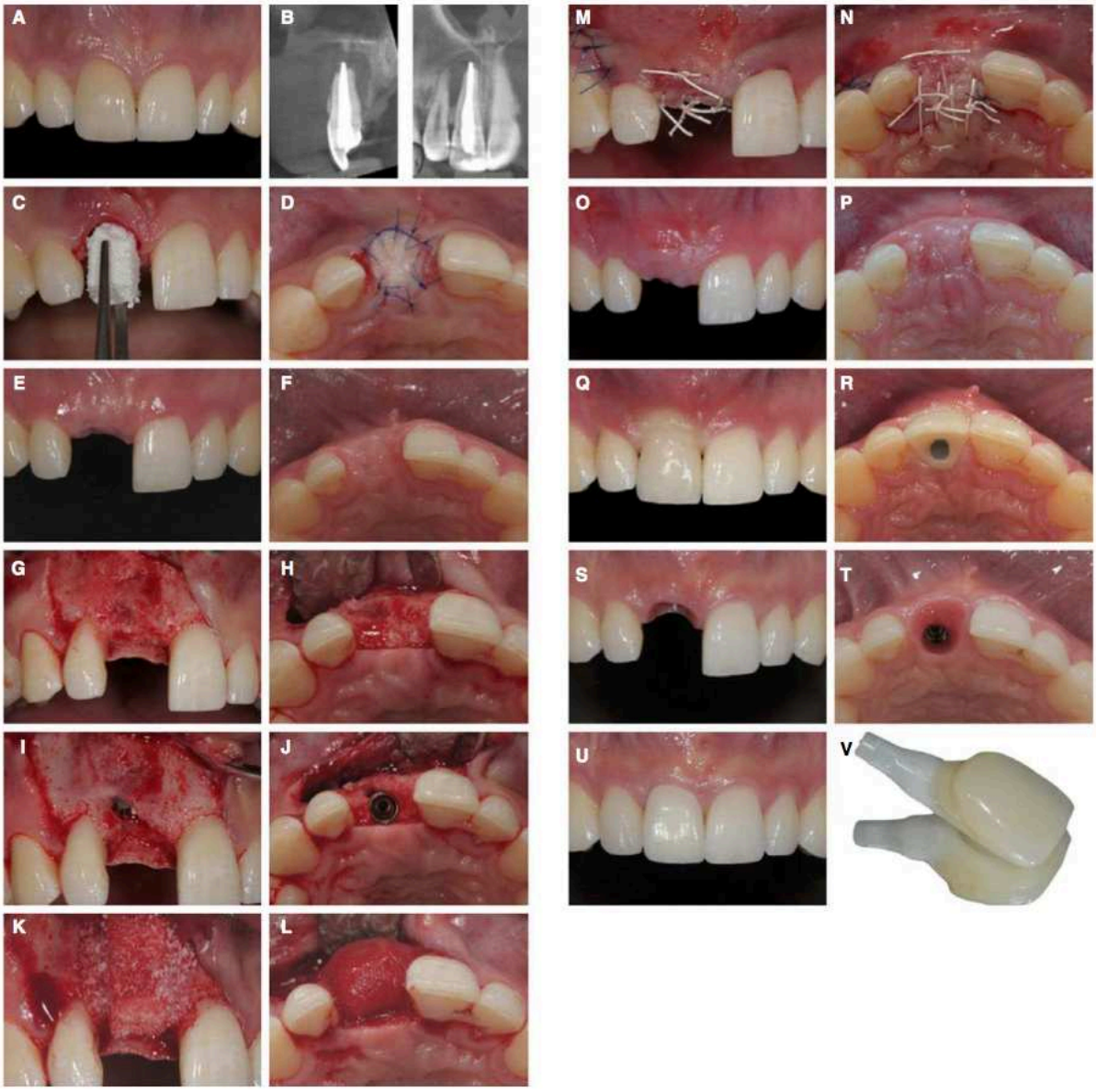


Figure 4

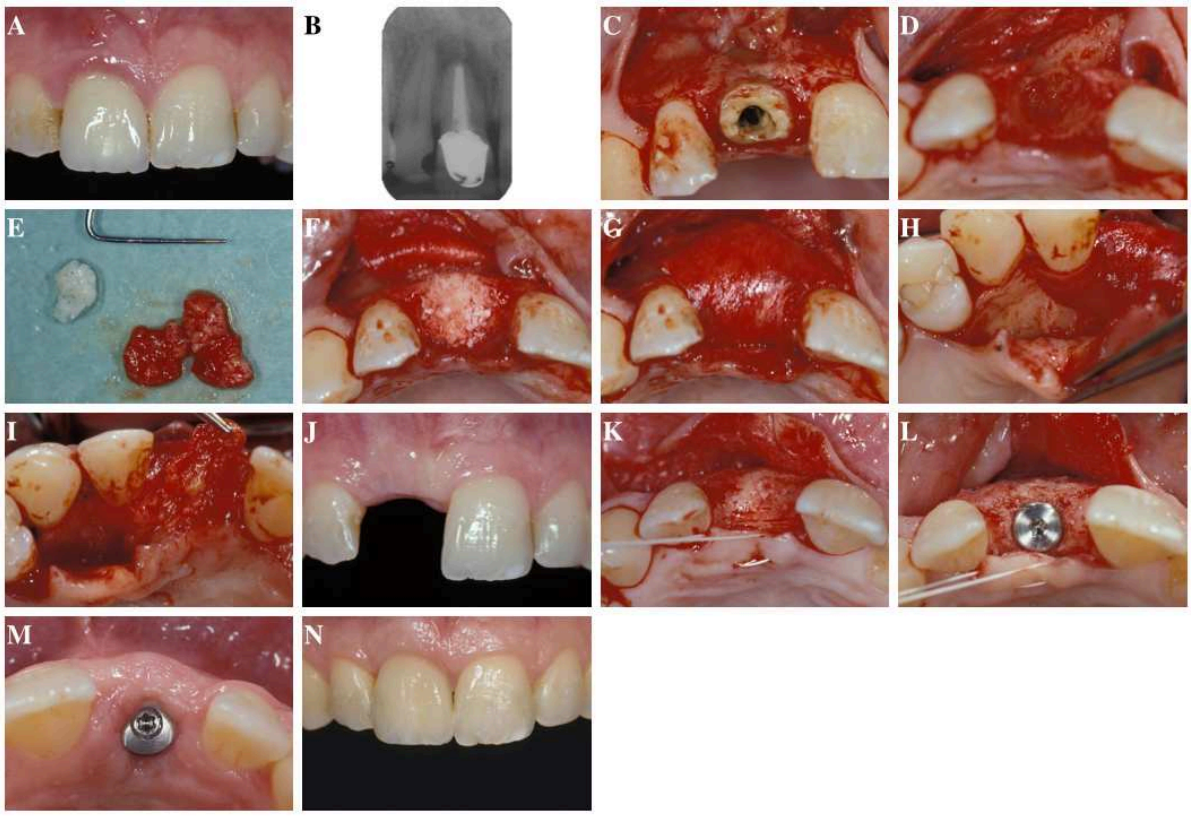


Figure 5